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# Does Vibration Training Increase Stability in Functionally Unstable Ankles?

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# **Does vibration training increase stability in functionally unstable ankles?**

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences – Physician Assistant

Department of Physician Assistant Studies  
Philadelphia College of Osteopathic Medicine  
Philadelphia, Pennsylvania

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## Abstract

Objective: The objective of this selective EBM review is to determine whether or not vibration training increases stability in functionally unstable ankles.

Study Design: Review of three English language randomized control trials (RCTs) published in 2006, 2008 and 2010.

Data Sources: Three non-blind randomized control trials found via PubMed.

Outcome(s) Measured: Efficacy was measured with one (experimental) group receiving vibration training and the other (control) group using either non-vibration exercise techniques or no exercise. Increased stability was measured with electromyography (EMG), balance testing or an isokinetic dynamometer.

Results: Vibration training is a useful tool to increase the stability in functionally unstable ankles; however, it needs further research to determine its efficacy compared to conventional modes of rehabilitation. One randomized control trial demonstrated that after the experimental period (four weeks), there was no significant increase in stability and therefore renders vibration training ineffective.

Conclusions: Overall, vibration training alone is not yet a useful tool for the rehabilitation of functionally unstable ankles.

Key Words: “*vibration training*”, “*ankle instability*”

## INTRODUCTION

Ankle instability is characterized as the feeling that an ankle is going to “give way” and evert, or more commonly invert. One reason for ankle instability is the recurrence of ankle sprains. As the ligaments of the ankle are repeatedly stretched or torn, inflammation and pain may subside, however, the ligaments may be permanently lengthened. This can create instability in the ankle and perpetuate chronic instability and make the ankle prone to injury. Physical activity involving pivoting, jumping or running can cause ankle injuries and even individuals with joint hypermobility can experience ankle sprains.

According to the American Academy of Family Physicians, ankle sprains are one of the most common reasons for primary care visits with an overall incidence of 2.15 per 1,000 individuals. Nearly one-half of the ankle sprains occur due to physical activity.<sup>5</sup> Proper treatment is needed for ankle sprains because there is a high incidence of recurrence once an individual experiences an initial ankle injury.

About 35% of all practicing physician assistants in the United States are in primary care or emergency medicine. Therefore it will be common for physician assistants to be exposed to a variety of ankle injuries.<sup>6</sup> In 2008, the average cost of an emergency room visit was about \$1300 and office based visits were substantially less at \$200.<sup>7</sup> Depending on the amount of imaging and therapy performed at these visits, costs can increase greatly. If an ankle injury requires a referral to an orthopedist or warrants physical therapy, costs to the individual increase as well. Due to compliance and severity, it is not realistic to determine a specific the number of medical visits one may need to properly rehabilitate an unstable ankle.

Ankle injuries and long term instability continues to be researched. Inversion ankle sprains are more common due the anatomy of the foot. When the ankle is inverted and internally rotated, the anterior talofibular ligament and other lateral ligaments are prone to stretching or tearing with any force. Once there is initial injury to the lateral ligaments, recurrence is common. Many ankle injuries are not treated properly and this may be the reason why recurrence is high.

Common treatments for ankle injuries aim to reduce pain and inflammation. The Rest, Ice Compression, Elevation (RICE) method is used in acute ankle injuries to promote healing and reduce swelling and pain. Non-steroidal anti-inflammatory drugs (NSAIDS) are used to decrease the inflammation as well. After an acute injury, physical therapy can “retrain” the ankle and strengthen the surrounding lower leg muscles. Reconstructive surgery is an option for individuals who experience severe injuries (i.e. grade III sprains). Bracing provides support in an active individual to prevent reoccurrence.

Vibration training use in the rehabilitation of ankle injuries and instability focuses on increasing lower leg muscle strength and balance. Vibration training can increase the neuromuscular receptivity through continuous proprioceptive stimulation.

## OBJECTIVE

The objective of this selective EBM review is to determine whether or not vibration training increases stability in functionally unstable ankles.

## METHODS

Specific selection criteria of three randomized control trials (RCTs) were used for this review. Although each of the trials had specific criteria, a common trend was seen in

all three. The populations used were individuals between the ages of 18 and 27. These individuals were ambulatory, had no recent ankle injuries within six weeks of the study and reported ankle injuries in the past. The intervention used in each of the studies was whole body vibration training. Comparisons were made between the groups that underwent vibration training and the control groups that used other means of ankle exercises or no exercises at all. The outcomes of the three randomized control trials decided if vibration training was an effective way of increasing stability in the individual's ankles.

All three of the RCTs were written in English and discovered in published peer review journals. The main keywords used in the search for the three RCTs were ankle instability and vibration training. The author searched and selected the articles through the PubMed database and were based on the relativity to the question proposed. Inclusion criteria included articles from 1996 to the present, randomized control trials and if the resulting data could be expressed as a POEM. Exclusion criteria included articles before 1996, articles that were not randomized control trials and studies that did not include vibration training. The statistics used in the articles were p-values, t-tests and standard deviations. Table 1 expresses the specific demographics, inclusion and exclusion criteria of each trial used in this review.

Table 1: Demographics and Characteristics of included studies

Study	Type	# Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Intervention
Costantino, C., et al. <sup>3</sup>	RCT	17	20-30	Sedentary Lifestyle Right-handed Females	Prior Ankle Sprains	0	Vibration Training

Cloak, R., et al. <sup>1</sup>	RCT	38	19±1.1	Self reported unilateral chronic ankle instability History of more than one lateral ankle sprain within the past two years Recurrent feeling of the ankle “giving away” CAIT (Cumberland Ankle Instability Tool) of ≤23	Ankle injury during the previous 6 weeks before testing Any balance or vestibular disorders History of lower limb breaks or fractures, previous ankle, knee or hip surgery or head injury.	0	Vibration Training
Menlyk, M., et al. <sup>4</sup>	RCT	26	24.1±2.8	Healthy physically active adults	No history of neurological disorders or orthopedic injuries	0	Vibration Training

### OUTCOMES MEASURED

To determine if vibration training was effective in stabilizing a functionally unstable ankle is the main outcome measured. Each of the three studies compared the individuals who received vibration training to individuals that received other means of exercise or no exercise at all. In the study by Costantino et al, vibration training therapy was compared to thera-band therapy and outcomes were measured with an isokinetic dynamometer to determine whether there was increased strength in the surrounding lower leg muscles and therefore increased stability in the ankle. In the study by Cloak et al, vibration training was compared to no exercise modalities. EMG activity of the long

peroneal and anterior tibialis muscles were measured before and after the experimental phase of both groups. The study used the Star Excursion Balance Test (SEBT) to measure the increase in stability of the affected ankle. In the study by Menlyk et al, the control group received no therapeutic intervention and the experimental group received vibration training. The test measured static balance and center of mass distribution before and after a six-week interval.

## RESULTS

The three randomized control trials in this review evaluated the efficacy of vibration training on functionally unstable ankles. The data in each of the trials contained continuous data, and therefore the analysis of risk reduction, absolute risk reduction and the number needed to treat were not evaluated.

In the study by Constantino et al, 17 females from ages 20-30 participated in a two-week, non-blind, randomized study. They were divided into an experimental group and a control group. The experimental group performed daily vibration therapy training, while the other performed series of thera-band exercises. Both groups were tested with an isokinetic dynamometer before and after the two weeks. The peak torque, power and total work of the plantar and dorsal flexors muscles were analyzed. Also, a power test was performed at an angular velocity of 60°/sec for five repetitions and a resistance test at an angular velocity of 180°/sec for twenty repetitions.<sup>3</sup>

At the conclusion of the study, it was determined that both groups developed an increase in strength in both plantar and dorsal muscles group. However, the experimental group showed a higher increase in peak torque in the dorsal flexor muscles at an angular velocity of 60°/sec ( $p=0.042$ ). It also showed a significantly higher increase in peak



torque, power and total work of the plantar muscles at an angular velocity of 60 °/sec ( $p=0.032$ ,  $p=0.007$ ,  $p=0.034$  respectively). Lastly, it showed a significantly higher increase in peak torque, power and total work of the plantar muscles at an angular velocity at 180°/sec ( $p=0.025$ ,  $p=0.02$ ,  $p=0.027$  respectively) compared to the control group.

Table 2: Peak torque of dorsal flexor muscles at an angular velocity of 60°/sec

	Control group			Study group		
Dorsal flexor muscles 60°/sec	Before training	After training	Increase	Before training	After training	Increase
Peak torque	22.36 N/m	30.77 N/m	<b>8.41 N/m</b>	27.32 N/m	39.34 N/m	<b>12.02 N/m</b>

Table 3: Peak torque, power and total work of plantar flexor muscles at an angular velocity of 60°/sec

	Control group			Study group		
Plantar flexor muscles 60°/sec	Before training	After training	Increase	Before training	After training	Increase
Peak torque	48 N/m	62.57 N/m	<b>14.57 N/m</b>	53.67 N/m	80.24 N/m	<b>26.57 N/m</b>
Power	26.77 N/m	36.67N/m	<b>9.9 N/m</b>	32.6 N/m	52.12 N/m	<b>19.52 N/m</b>
Total work	126.41 N/m	157.87N/m	<b>31.46 N/m</b>	149.31 N/m	223.09 N/m	<b>73.78 N/m</b>

Table 4: Peak torque, power and total work of plantar flexor muscles at an angular velocity of 180°/sec

	Control group			Study group		
Dorsal flexor muscle 60°/sec	Before training	After training	Increase	Before training	After training	Increase
Peak torque	25.26 N/m	35 N/m	<b>9.74 N/m</b>	31.82 N/m	51.41 N/m	<b>19.59 N/m</b>
Power	34.87 N/m	51.02 N/m	<b>16.15 N/m</b>	36.94 N/m	66.9 N/m	<b>29.96 N/m</b>
Total work	354.91 N/m	478.11N/m	<b>123.2 N/m</b>	355.6 N/m	629.40 N/m	<b>273.8 N/m</b>

In the study by Cloak et al, 38 female dancers between the ages 18 and 20 participated in a six-week, non-blind, randomized study. The experimental group received daily vibration training while the other group refrained from any ankle

strengthening exercises. The absolute center of mass distribution during a single leg stance test and the distances reached during the Star Excursion Balance Test were measured before and after the experimental phase. The Star Excursion Balance Test (SEBT) has an individual stand on the unstable ankle barefoot and reach along an eight-lined star-cross (in 45° increments). The participant uses their non-weight bearing leg to reach the most distal part of the line on the star. Using the length of the participant's leg and the distance away from the center of the star-cross, the percentage of leg length was used to normalize the data.

At the conclusion of the study, it was determined that there was a larger decrease in center of mass distribution of the individuals who participated in vibration therapy than those in the control group. This means that there was an increase in postural stability. Also, in the SEBT, 4 planes of motion (anterior, anterior medial, medial and anterior lateral) had a significant improvement in the experimental group than those in the control group.

Table 5: Means and SD of percentage of mass distribution in cm<sup>2</sup>

	Vibration group		Control group		
	Pre	Post	Pre	Post	P-value
Center of mass distribution (cm <sup>2</sup> )	1.05 ±0.57	0.33± 0.42	1.01 ±0.44	0.82± 0.46	0.04

Table 6: Means and SD of normalized reach distances (%)

	Vibration group		Control group		
Planes	Pre	Post	Pre	Post	P-value
Anterior	75.5 ±7.1	80.2 ±7.2	74.7 ±6	74.9± 6.1	0.036
Anterior medial	81± 5.5	85 ±9.2	79.1 ±6	78.1± 7.7	0.038
Medial	84.8± 8	92± 12.5	82.4± 6.6	83.7 ±7.8	0.047
Anterior lateral	68.6± 9.4	79.4± 8.5	70.5± 8.9	74.7 ±9.7	0.015

In the study by Menlyk et al , 26 physically active males and females were divided into the control group (n = 10) and the experimental group (n =16). Each of the participants completed the four-week, non-blind randomized study. The experimental group received vibration training three times per week and the reflex (EMG) activity of the long peroneal and tibialis anterior muscles were measured. The control group refrained from any ankle strengthening activities. Both groups were tested before and after the experimental phase.

At the conclusion of the study, it was determined that there was not a significant difference in EMG activity of the long peroneal and the tibialis anterior muscles compared to the control group (tibialis anterior:  $p=0.186$ , long peroneal:  $p=0.863$ ).

## DISCUSSION

This systematic review discussed three RCTs that evaluated the effectiveness of vibration training in rehabilitating functionally unstable ankles. All three studies described vibration training as a safe and effective way for rehabilitation, however, more research is needed and should not be the sole method of rehabilitation. Vibration training is fairly new in the rehabilitation field and it would be beneficial to the field if there was more comprehensive research.

There were several limitations in the RCTs. Besides the number of participants and the time limitations, a standard way of measuring stability should be implemented. While some trials used EMG activity, others used methods like SEBT that do not measure the lower extremity muscle activity, therefore, it is difficult to assess if the

muscles are being properly used or if there are other compensatory muscles being used in the body.

Any type of new intervention may face financial issues that prevent them from penetrating their specific discipline. Vibration training therapy has not proven itself to be more effective than traditional rehabilitation methods. Until it can offer something that the other methods are not able, it may be difficult for vibration training to gain universal use.

It also may be beneficial to limit the type of population within a study. Instead of enlisting either sedentary or athletic individuals in the same study, segregating a type of physical activity may help pinpoint a population better suited for vibration training.

There are some contraindications to vibration training that may limit its use. Severe osteoporosis, diabetic neuropathy and old age are relative contraindications due to the fall risk. Even though in these three RCTs only ambulatory younger individuals were studied, increasing research is being conducted to recognize the benefit of vibration training in older individuals with gait abnormalities and weakness in the lower extremities, including unstable ankles.

## CONCLUSION

The answer to the proposed question is conflicting and inconclusive. The RCTs do not state that vibration training should not be used, but they express that there is not enough evidence that vibration training is more beneficial as a sole means than traditional methods. Future studies should focus on specific types physical activity disciplines and note vibration training on each of them separately. Each of these studies were short in duration and the interventions duration the experimental period could be more extensive.

Longer and more consistent vibration therapy sessions may elicit a more complete answer to the question. Vibration therapy may be beneficial to individuals who combine it with other types of traditional therapy. Measuring the efficacy of vibration training to other methods of rehabilitation such as balance boards, heel raises, jumping rope and other static and dynamic exercises should be the next step in to determining if vibration therapy has a solid chance to be used in the rehabilitation field.

## References

1. Cloak R, Nevill AM, Clarke F, Day S, Wyon MA. Vibration training improves balance in unstable ankles. *Int J Sports Med*. 2010;31(12):894-900. doi: 10.1055/s-0030-1265151; 10.1055/s-0030-1265151.
2. Coplan B, Cawley J, Stoehr J. Physician assistants in primary care: Trends and characteristics. *Ann Fam Med*. 2013;11(1):75-79. doi: 10.1370/afm.1432; 10.1370/afm.1432.
3. Costantino C, Pogliacomi F, Soncini G. Effect of the vibration board on the strength of ankle dorsal and plantar flexor muscles: A preliminary randomized controlled study. *Acta Biomed*. 2006;77(1):10-16.
4. Melnyk M, Schloz C, Schmitt S, Gollhofer A. Neuromuscular ankle joint stabilisation after 4-weeks WBV training. *Int J Sports Med*. 2009;30(6):461-466. doi: 10.1055/s-0028-1112141; 10.1055/s-0028-1112141.
5. Tiemstra JD. Update on acute ankle sprains. *Am Fam Physician*. 2012;85(12):1170-1176.
6. Vital Statistics.  
[www.aapa.org/iploadedFiles/content/News\\_and\\_Publications/For\\_the\\_Media/VitalStats\\_Factsheets](http://www.aapa.org/iploadedFiles/content/News_and_Publications/For_the_Media/VitalStats_Factsheets). Published January 2013. Accessed December 1<sup>st</sup>, 2013
7. Machlin S and Chowdhury S. Expenses and characteristics of physician visits in different ambulatory care settings, 2008. MEPS [Medical Expenditure Panel Survey] Statistical Brief #318, March 2011